measurement. Thus, the sample holding stage may use X, Y, and Z, as well as r-θ type movement and there is no requirement that the polarization orientation of the incident light be aligned with the grating of the diffraction structure. A non-linear multivariate regression process is used to adjust the parameters of an optical model, such as rigorous coupled-wave analysis, to provide a match with the measured data.

In the Claims

Please replace Claims 3, 7, 9-12, 13 with the following like-numbered claims. Claims 1, 2, 17-26, and 29 have been cancelled. A complete claim set is included for the Examiner's convenience.

Please cancel Claim 1.

Please cancel Claim 2.

3. (Amended) An apparatus for measuring one or more parameters of a diffracting structure on a sample, said apparatus comprising:

a radiation source that emits broadband radiation;

a polarizing element, said radiation passing through said polarizing element toward said sample, said radiation being normally incident on and reflected off said diffracting structure on said sample, said reflected radiation passing through said polarizing element, at least one of said polarizing element and said sample are rotatable to produce a relative rotation between said polarizing element and said diffracting structure;

a spectrograph that detects the intensity of spectral components of said reflected radiation after passing through said polarizing element at a plurality of polarization orientations between said polarizing element and said diffracting structure;

wherein said spectrograph produces a spectrograph signal for said spectral components and a plurality of polarization orientations, said apparatus further comprising a computer system for analyzing said spectrograph signal to determine said one or more parameters of said diffracting structure on said sample, said computer system comprising:

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at least one computer connected to said spectrograph to receive said spectrograph signal; and

a computer program executed by said at least one computer, wherein said computer program includes instructions for:

extracting spectral information from said spectrograph signal;

constructing an optical model simulating said diffracting structure using at least one variable parameter;

calculating spectral information for said optical model; and

curve fitting said calculated spectral information to said extracted spectral information to determine said one or more parameters of said diffracting structure on said sample.

4. The apparatus of Claim 3, wherein said computer instructions for curve fitting comprise computer instructions for using a non-linear regression routine.

5. The apparatus of Claim 3, wherein said computer instructions for curve fitting comprise computer instructions for:

comparing said extracted spectral information and said spectral information for said optical model;

adjusting said at least one variable parameter of said optical model;

recalculating spectral information for said optical model;

comparing said extracted spectral information and said recalculated spectral information for said optical model; and

repeatably adjusting said at least one variable parameter, recalculating spectral information for said optical model, and comparing said extracted spectral information and said recalculated spectral information for said optical model until an acceptable fit is achieved.

6. The apparatus of Claim 3, wherein said computer instructions for constructing an optical model and calculating spectral information for said optical model comprise computer instructions for using rigorous coupled-wave analysis.

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7. (Amended) An apparatus for measuring one or more parameters of a diffracting structure on a sample, said apparatus comprising:

a radiation source that emits broadband radiation;

a polarizing element, said radiation passing through said polarizing element toward said sample, said radiation being normally incident on and reflected off said diffracting structure on said sample, said reflected radiation passing through said polarizing element, at least one of said polarizing element and said sample are rotatable to produce a relative rotation between said polarizing element and said diffracting structure;

a spectrograph that detects the intensity of spectral components of said reflected radiation after passing through said polarizing element at a plurality of polarization orientations between said polarizing element and said diffracting structure;

wherein said spectrograph produces a spectrograph signal for said spectral components and a plurality of polarization orientations, said apparatus further comprising a computer system for analyzing said spectrograph signal to determine said one or more parameters of said diffracting structure on said sample, said computer system comprising:

at least one computer connected to said spectrograph to receive said spectrograph signal; and

a computer program executed by said at least one computer, wherein said computer program includes instructions for extracting spectral information from said spectrograph signal wherein said computer instructions for extracting spectral information from said spectrograph signal comprise computer instructions for:

calculating the sample reflectance for a plurality of wavelengths of said radiation and a plurality of polarization orientations of said polarizing element relative to said diffracting structure; and

curve fitting said sample reflectance for said plurality of wavelengths and said plurality of positions with:

$$R(\Theta) = A \cdot \cos^4(\phi - \Theta) + B \cdot \sin^4(\phi - \Theta) + C \cdot \cos^2(\phi - \Theta) \cdot \sin^2(\phi - \Theta)$$

where $R(\Theta)$ is the measured reflectance at one wavelengths, Θ is the polarization orientation of said polarizing element with respect to

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said diffracting structure, and ϕ, A, B, and C, measurable, to obtain said spectral information.

8. The apparatus of Claim 7, wherein said computer instructions for curve fitting comprise computer instructions for using a non-linear regression routine.

9. (Amended) The apparatus of Claim 3, wherein said spectrograph comprises:

a dispersing element that disperses said polarized beam into spectral components; and

an array of detector pixels that detect the intensity of said spectral components.

10. (Amended) The apparatus of Claim 3, wherein said polarizing element is a rotatable polarizing element that rotates relative to said diffracting structure.

11. (Amended) An apparatus for measuring one or more parameters of a diffracting structure on a sample, said apparatus comprising:

a radiation source that emits broadband radiation;

a polarizing element, said radiation passing through said polarizing element toward said sample, said radiation being normally incident on and reflected off said diffracting structure on said sample, said reflected radiation passing through said polarizing element, at least one of said polarizing element and said sample are rotatable to produce a relative rotation between said polarizing element and said diffracting structure;

a spectrograph that detects the intensity of spectral components of said reflected radiation after passing through said polarizing element at a plurality of polarization orientations between said polarizing element and said diffracting structure; and

a sample stage, said sample being held on said sample stage, wherein said sample stage rotates said diffracting structure relative to said polarizing element.

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12. (Amended) An apparatus for measuring one or more parameters of a diffracting structure on a sample, said apparatus comprising:

a radiation source that emits broadband radiation;

a polarizing element, said radiation passing through said polarizing element toward said sample, said radiation being normally incident on and reflected off said diffracting structure on said sample, said reflected radiation passing through said polarizing element, at least one of said polarizing element and said sample are rotatable to produce a relative rotation between said polarizing element and said diffracting structure;

a spectrograph that detects the intensity of spectral components of said reflected radiation after passing through said polarizing element at a plurality of polarization orientations between said polarizing element and said diffracting structure; and

an r-θ sample stage, said sample being held on said r-θ sample stage.

13. (Amended) A method of measuring at least one parameter of a diffracting structure, said method comprising:

(a) passing broadband radiation through a polarizing element to produce polarized radiation;

(b) directing said polarized radiation to be normally incident with said diffracting structure, said polarized radiation being reflected off said diffracting structure;

(c) analyzing the reflected radiation with said polarizing element to produce an output beam with a polarity orientation;

(d) detecting the intensity of spectral components of said output beam;

(e) producing a relative rotation between said polarizing element and said diffracting structure to alter the orientation of said polarized element relative to said diffracting structure and repeating steps a through d;

(f) repeating step e for a plurality of orientations of said polarizing element and said diffracting structure; and

(g) using said detected intensities of said spectral components of said output beam for a plurality of orientations to determine said at least one parameter of said diffracting structure.

14. The method of Claim 13, further comprising:

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generating a reference database of different diffracting structures having at least one variable parameter related to a plurality of wavelengths and a plurality of orientations;

comparing said detected intensities of said spectral components to said database to determine said at least one parameter of said diffracting structure.

15. The method of Claim 13, wherein producing a relative rotation between said polarizing element and said diffracting structure comprises rotating said polarizing element.

16. The method of Claim 13, wherein producing a relative rotation between said polarizing element and said diffracting structure comprises rotating said diffracting structure.

sub B2

27. An apparatus for measuring one or more parameters of a diffracting structure on a sample, said apparatus comprising:

a radiation source that emits broadband radiation, said radiation is normally incident on said diffracting structure;

a polarizing element in the beam path of said broadband radiation;

an r-θ sample stage for holding said sample with said diffracting structure; and

a spectrograph that detects the intensity of spectral components of radiation reflected off said diffracting structure.

28. The apparatus of Claim 27, wherein said radiation passes through said polarizing element toward said sample, said radiation is reflected off said diffracting structure on said sample, said reflected radiation passing through said polarizing element, said polarizing element being rotatable to produce a relative rotation between said polarizing element and said diffracting structure.

Please cancel Claim 29.

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